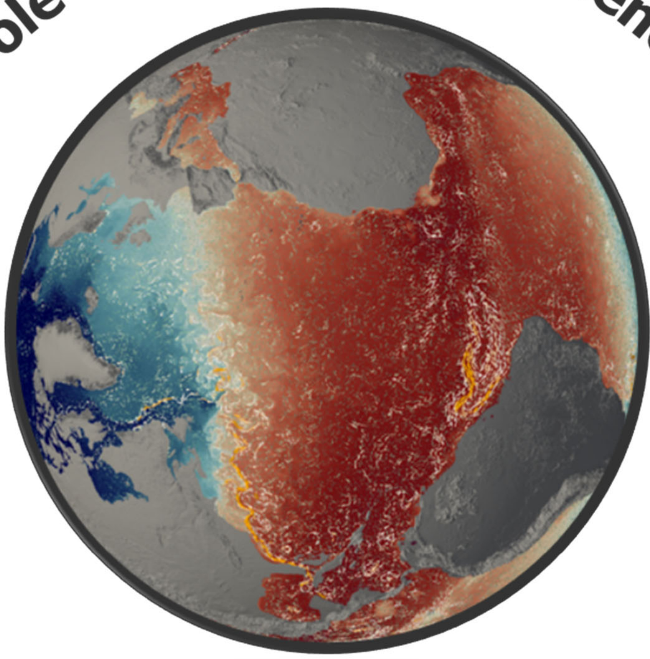
Atlantic Pole to Pole: Climate Science 2 Policy



What kind of research priorities should be taken into account in establishing a framework for international collaboration in the next decades?

\- POLICY BRIEF -

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Summary

Under climate change, the world faces global challenges that can only be met through science diplomacy and the use of scientific collaborations among nations, to address borderless climate risks. Researchers, decision-makers and knowledge-brokers have a responsibility to develop and maintain the flow of information to create evidence-based and equitable outcomes with and for society. Initiatives such as the All-Atlantic Ocean Research Alliance and other EU mechanisms have been working towards facilitating effective science diplomacy across the whole Atlantic region.

The Atlantic Ocean remains a key area for research and science diplomacy in the coming years, due to the huge climatic, environmental and economic importance. In the north, the Atlantic Meridional Ocean Circulation plays a major role in driving climate variability of many ocean and atmosphere systems. In the south, ocean circulation sinks to the bottom of the ocean, propagating climate signals to the ocean abysses, and participating in buffering climate change. Abrupt changes in these circulation systems could have major impacts on ecosystems and societies.

Scientific cooperation and management responses as well as long-term strategies for sustained Atlantic observations are critical to fill in research gaps.

This briefing highlights the importance of connected, interdisciplinary long-term science and ocean monitoring to understand global physical systems, make predictions and inform future policy.

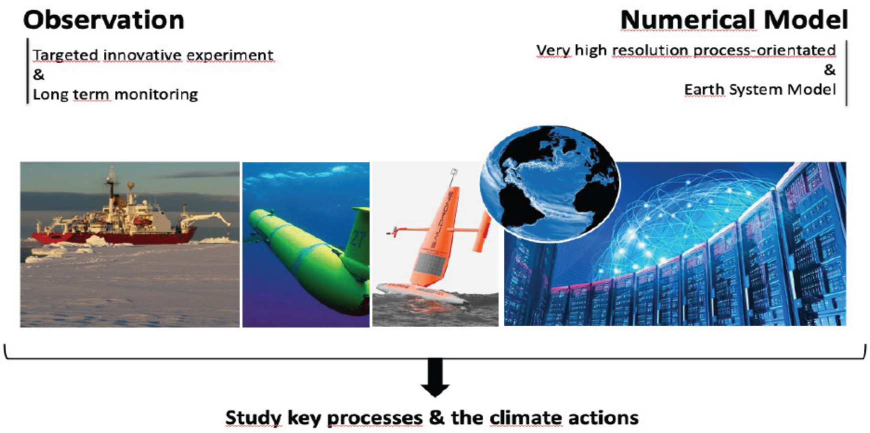
Ultimately, we invite participants to discuss what kind of research priorities should be taken into account in establishing a framework for international collaboration in the next decades?

Key take-home messages

- The Atlantic Ocean is a **climate regulator**, a vital source of **food and income**, and the **host of complex marine ecosystems**.
- **Integrated ecosystem assessments** are critical to evaluate and manage risks and vulnerabilities of these ocean socio-ecological systems, informing the management of ecosystems' goods and services supporting the populations in the Atlantic.
- **Long-term, sustained observations** of the Atlantic, Southern and Arctic Ocean, are required to inform climate predictions and develop a **Digital Twin of the Ocean and Earth Systems**. Using these observations we can predict the climate more precisely over longer time scales, particularly in the North Atlantic.
- Information at **regional and local scales** is needed to support climate change adaptation and prepare for extreme events.
- Results from global climate models are (highly) uncertain for **polar regions** and need to be improved to better represent key processes; this calls for higher resolution and incorporation of critical **Earth system feedbacks** (e.g. permafrost thaw and ice shelf-ocean interaction).
- Climate change adaptation requires **knowledge co-production and transdisciplinary efforts**, including the use of storylines and narratives to bridge the gap between model outputs and policy recommendations. Interdisciplinary collaborations will allow a joint global response to climate challenges and risks.
- Climate research is not only a topic of interest for climate scientists. Climate affects millions of people, especially those who live in coastal areas or in ocean states. Resources procured from the ocean are vital for **developing and least developed countries** surrounding the Atlantic Ocean. Therefore, understanding, predicting and managing the Atlantic physical and eco- systems in a sustainable way is in the interest of humanity.
- To make sound management decisions, policy-makers and decision-makers must be provided with scientific results derived from **multidisciplinary teams** of climate and ecosystem scientists, oceanographers, modellers, and social scientists. All these efforts will require a **science diplomacy strategy** to balance countries' interests, needs, and capabilities and produce the necessary cross-disciplinary ocean science to better serve policy and society at large.

Research needs and priorities

- Natural and social scientists, experts from disciplines such as law, policy, public health, education, media, along with decision-makers, diplomats, and other stakeholders must **collaborate to identify policy relevant research questions and carry out research**. Such inclusive, transdisciplinary collaboration is essential to identify the full range of social-ecological uncertainties, to develop indicators, scenarios, monitoring programs, models and forecasts of global social ecological systems for decision-making. This exercise must be accomplished for the entire Atlantic, Antarctic to Arctic, East to West, seabed to surface.
- **Risks of Atlantic Meridional Overturning Circulation collapse** and associated impacts must be evaluated in a suite of models, taking into account key uncertainties (e.g. meltwater runoff from icecaps) and making optimal use of Earth Observations and direct measurements.
- New efforts are also needed to advance research on physical systems and the independent dynamics of the whole **Atlantic ocean and its connections with both poles and global circulation,** including abrupt changes beyond the AMOC, and the interplay between the unprecedented subpolar ocean changes and Polar Regions.
- Further work is needed to understand Improvements in the **ability of climate models to represent processes** related to **Atlantification and Pacification** are required to reduce uncertainty in future projections in the Arctic and Northern Hemisphere.
  Substantial biases in climate models in the Polar Regions must be urgently reduced through improving parameterizations, increasing resolution, incorporating important Earth system feedbacks and through diagnosing the origin of biases by confronting models with observations.



- A **greater understanding of the Southern Ocean** must be developed, including monitoring ocean and marine biodiversity essential variables. Understanding of ocean, atmosphere, and cryosphere feedbacks in the subpolar Southern Ocean must be improved by sustained Southern Ocean observations and improved coupled models.
- The gap between observational and modelled studies on the influence of **Arctic sea ice loss** on mid-latitude atmospheric circulation and climate extremes must be reduced. A greater quantitative understanding of the impact of warming permafrost on the land-to-sea continuum is needed.
- **Participatory processes** further engaging citizens should be promoted, particularly around integrated ecosystem assessments.
- Climate change must be made more tangible by developing plausible **storylines to illustrate future warming scenarios** ("pictures of the future").
- Understanding and predicting how **socio-ecological systems** may be affected and identifying options for societal response is key to helping decision-makers.

MISSION ATLANTIC

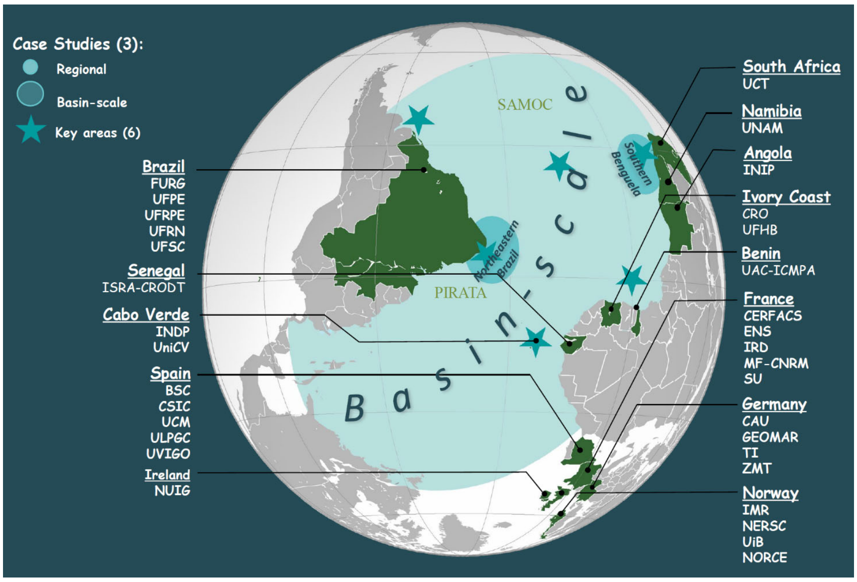
MISSION ATLANTIC develops and systematically applies Integrated Ecosystem Assessments (IEAs) in the Atlantic Ocean. IEAs enable identification of ecosystem components most at risk from natural hazards and the consequences of human activities. The project employs all available information on those sources, the pressures they impose and the ecosystem components that are affected, to identify the most important risk factors for sustainable development of the Atlantic Ocean. MISSION ATLANTIC develops and tests high-resolution numerical ocean ecosystem models, as well as employing advanced statistical approaches, artificial neural networks, and risk assessment methods in support of the IEA cycle. Cross-Atlantic seagoing activities will collect new observations on the shelf and open ocean, across benthic and pelagic biomes, to validate ecosystem models and explore the biogeography of plankton and fish communities. Advanced combinations of marine robotic solutions and acoustic sensors are further developed and deployed to provide new data and to deliver the next generation of autonomous systems in support of IEAs.

MISSION ATLANTIC aims at supporting ocean science diplomacy through the All-Atlantic Ocean Research Alliance, which is based, *inter alia*, in the implementation of the Galway and Belém Statements. Following the Galway Statement, which focuses on North-Atlantic cooperation, the Belém statement furthers the integrated approach to research and development across the whole Atlantic Ocean and its bordering countries, bridging diverse communities of researchers and practitioners with society. Thus, MISSION ATLANTIC applies ocean science diplomacy as a facilitator of IEAs from the regional to the All-Atlantic basin scale, contributing to the All-Atlantic Ocean Research Alliance.

TRIATLAS

TRIATLAS contributes to the sustainable management of human activities affecting Atlantic marine ecosystems. Optimal functioning of marine ecosystems is critical not only for their health but also for the blue economy of countries bordering them. The effects of climate change and other stressors on marine ecosystems act across the Atlantic basin and are also economically interconnected. The European Union has recognized the importance of this interconnectedness by supporting the Galway and Belém Statements, and building the All-Atlantic Ocean Research Community.

TRIATLAS employs a basin-wide approach while focusing on the Tropical and South Atlantic where critical knowledge gaps impede an understanding of the entire basin. An interdisciplinary team of marine ecologists, climate researchers, oceanographers, and social scientists from Africa, Brazil, and Europe collaborate to enhance the knowledge of Atlantic marine ecosystems by using existing and new observational methods.



Combining the physical, biological, and societal observations with earth system, ecological, and socio-economic models, TRIATLAS aims to assess the cumulative impact of various pressures causing fluctuations in Atlantic marine ecosystems, potential for tipping point behaviour, and regime shifts. Finally, TRIATLAS is developing the first predictions of marine ecosystems for the whole Atlantic for the next 40 years that can be used for decision making, by integrating multidisciplinary observations into state-of-the-art climate prediction systems and ecosystem models.

SO-CHIC

The Southern Ocean regulates the global climate by controlling heat and carbon exchanges between the atmosphere and the ocean. Rates of climate change on decadal time scales ultimately depend on oceanic processes taking place in the Southern Ocean, yet too little is known about the underlying processes. Limitations come both from the lack of observations in this extreme environment and its inherent sensitivity to intermittent small-scale processes that are not captured in current Earth system models.

To contribute to reducing uncertainties in climate change predictions, SO-CHIC develops an ambitious observation and numerical modeling program in the Atlantic sector of the Southern Ocean to understand key ocean processes controlling exchanges between the atmosphere, ocean and ice, and how they affect global and regional climates. The Southern Ocean also hosts key interactions with the polar ice-shelf and the development of long-term, sustained observations is required to improve our understanding of these important interactions impacting sea-level rise and large-scale ocean circulation systems.

In particular, the links between the changing Atlantic Meridional Ocean Circulation (AMOC) and the changing Southern Ocean Meridional Ocean Circulation must be better understood. More generally, climate change in the remote Southern Ocean must be made more tangible by developing storylines that would raise awareness on its importance for our daily lives and for developing our adaptation and mitigation strategies.

Blue-Action

Businesses, policymakers, and local communities need to access reliable weather and climate information to safeguard human health, wellbeing, economic growth, and environmental sustainability. However, important changes in climate variability and extreme weather events are difficult to pinpoint and account for in existing modelling and forecasting tools. Moreover, many changes in the global climate are linked to the Arctic, where climate change is occurring rapidly, making weather and climate prediction a considerable challenge. In the past four years of its implementation, Blue-Action has evaluated the impact of Arctic warming on the northern hemisphere and developed new techniques to improve climate predictions accuracy at sub-seasonal to decadal scales. Blue-Action specifically worked to understand and simulate the linkages between the Arctic and the global climate system, and the Arctic's role in generating weather patterns associated with hazardous conditions and climatic extremes. In doing so, Blue-Action aimed to improve the safety and wellbeing of people in the Arctic and across the Northern Hemisphere, to reduce the risks associated with Arctic operations and resource exploitation, and to support evidence-based decision-making by policymakers worldwide.

To achieve this, Blue-Action has taken a transdisciplinary approach, bridging scientific understanding within Arctic climate, weather and risk management research with key stakeholder knowledge of the impacts of climatic weather extremes and hazardous events, leading to the co-design of better climate services. This bridge has been built on innovative statistical and dynamical approaches to predict weather and climate extremes. In dialogue with end-users and stakeholders in the Northern Hemisphere, Blue-Arctic has taken stock in existing knowledge about cross-sectoral impacts and vulnerabilities with respect to the occurrence of extreme events when associated with weather and climate predictions. Modelling and prediction capabilities have been enhanced by targeting firstly lower latitude oceanic and atmospheric drivers of regional Arctic changes and secondly, Arctic impacts on Northern Hemisphere climate and weather extremes. Coordinated multi-model experiments have been key to test new higher resolution model configurations, innovative methods to reduce forecast error, and advanced methods to improve uptake of new Earth observations' assets are planned. Blue-Action has demonstrated how such an uptake may assist in creating a better optimized observation system for various modelling applications and in supporting meteorological and climate services to better deliver tailored predictions and advice, including sub-seasonal to seasonal time scales.

About us

This side-event is co-organized by four Horizon 2020 funded research projects working on climate predictions in the Atlantic:

Blue-Action Arctic Impact on Weather and Climate (2016-2021)
focuses on changes in climate and weather in the Arctic, it works to develop and improve models that can predict climate from seasons to decades in advance.
https://www.blue-action.eu
Cordis: https://cordis.europa.eu/project/id/727852

MISSION ATLANTIC Towards the Sustainable Development of the Atlantic Ocean: Mapping and Assessing the present and future status of Atlantic marine ecosystems under the influence of climate change and exploitation (2020-2025) works to map and assess present and future status of Atlantic marine ecosystems under multiple stressors. The project analyzes the different approaches for science-diplomacy to inform ocean governance on a basin scale for the Atlantic; collects information from different stakeholders and evaluates options for the co-creation of IEA decision making tools and indicators.
http://www.missionatlantic.eu

SO-CHIC Southern Ocean Carbon and Heat Impact on Climate (2019-2024) seeks to understand and quantify variability of heat and carbon budgets in the Southern Ocean through an investigation of the key processes controlling exchanges between the atmosphere, ocean and sea ice. http://www.sochic-h2020.eu

TRIATLAS South and Tropical Atlantic Climate-based Marine Ecosystem Prediction for Sustainable Management (2019-2023) aims to inform sustainable management of human activities affecting Atlantic marine ecosystems that is critical to maintain ecosystem health and support the blue economy of bordering nations.
https://triatlas.w.uib.no

References

McCarthy, Gerard D., Peter J. Brown, Charles N. Flagg, Gustavo Goni, Loïc Houpert, Christopher W. Hughes, Rebecca Hummels et al. "Sustainable observations of the AMOC: Methodology and technology." *Reviews of Geophysics* 58, no. 1 (2020): e2019RG000654.

Olsen, Steffen, Årthun, Marius, Eldevik, Tor, Fritz, Jan-Stefan, Larsen, Karin, Miller, Raeanne, … Oltmanns, Marilena. (2018, September 3). The Slowing Gulf Stream? What we know and potential impacts (Policy Briefing) (Version 4 September 2018). Zenodo. http://doi.org/10.5281/zenodo.1408097

Payne, Mark, Keenlyside, Noel, Bearzotti, Chiara, de Jong, Femke, Fritz, Jan-Stefan, Grist, Hannah, … Meller, Laura. (2020, December 1). Forecasting fish distribution and abundance in the Atlantic Ocean: The challenge of balancing exploitation and sustainability (Policy briefing). Zenodo. http://doi.org/10.5281/zenodo.4289935

Polejack A (2021) The Importance of Ocean Science Diplomacy for Ocean Affairs, Global Sustainability, and the UN Decade of Ocean Science. Front. Mar. Sci. 8:664066. https://doi.org/10.3389/fmars.2021.664066

Polejack, A., Gruber, S. & Wisz, M.S. Atlantic Ocean science diplomacy in action: the pole-to-pole All Atlantic Ocean Research Alliance. Humanit Soc Sci Commun 8, 52 (2021). https://doi.org/10.1057/s41599-021-00729-6

Wisz, M. S., Satterthwaite, E. V, Fudge, M., Fischer, M., Polejack, A., John, M. S., … Rudd, M. A. (2020). 100 Opportunities for More Inclusive Ocean Research: Cross-Disciplinary Research Questions for Sustainable Ocean Governance and Management. Frontiers in Marine Science, 7(576), 1–23. https://doi.org/https://doi.org/10.3389/fmars.2020.0057

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